NONPOINT SOURCE POLLUTION CONTROL PROGRAM

The Kentucky Nonpoint Source Management Program document provides a comprehensive description of Kentucky's strategy for controlling nonpoint source (NPS) pollution. It was prepared by the Division of Water (DOW) in response to the requirements of the Water Quality Act of 1987 and received full approval from the U.S. Environmental Protection Agency (EPA) in November 1989. It describes those control measures, or best management practices (BMPs), that Kentucky will use to control pollution resulting from each NPS category (agriculture, construction, etc.) identified in the Kentucky NPS Assessment Report and in this report, the programs to achieve implementation of those BMPs, and a schedule for implementing those programs.

Because NPS pollution arises from a wide spectrum of diffuse sources throughout the Commonwealth, a variety of programs exists in a number of agencies which address NPS pollution control. The DOW serves as the lead oversight agency for these programs. Agencies and institutions cooperating in the implementation of Kentucky's NPS Management Program include the Kentucky Division of Conservation (DOC), Division of Forestry, Division of Waste Management, Division of Pesticides, Department for Surface Mining Reclamation and Enforcement, Kentucky Conservation Districts, Kentucky Geological Survey, U.S. Soil Conservation Service (SCS), U.S. Agriculture Stabilization and Conservation Service (ASCS), U.S. Forest Service, U.S. Geological Survey, U.S. Army Corps of Engineers, Tennessee Valley Authority, University of Kentucky Water Resources Research Institute, and University of Kentucky College of Agriculture.

Kentucky's NPS program has received $1,504,335 from EPA through Section 319 and 205(j)(5) grants for fiscal years 1990 and 1991. Currently, for fiscal year 1992, Kentucky has requested $389,000 for baseline funding and has submitted 14 project proposals for competitive funding.

Monitoring

Nonpoint source pollution problems in the waters of the Commonwealth originate from land-based activities. The direct interrelationship between land activities and water quality necessitates that both the terrestrial and the aquatic environments be monitored and evaluated. To this end, the NPS Pollution Control Program has formed two on-site planning field teams. Each team consists of a DOW field team leader with an aquatic ecology background and a DOC field team member with an agronomy/agriculture background.

The actual collection, assessment, evaluation, and interpretation of both water quality and land-based data is the responsibility of the field teams. Physical characteristics of the waterbody, water chemistry, aquatic biological community structure, and land-based activities are different aspects of the waterbody's ecosystem that

may be monitored. A multifaceted approach is necessary for NPS monitoring because of the mobility of NPS pollutants, the varying degrees of pollutant toxicity, the close interrelationship of land-based activities and NPS pollution, and the spatial and temporal variabilities that exist in natural, dynamic ecosystems. Nonpoint source standard operating procedures (SOPs) will provide instruction and guidance in, and will ensure standardization of, study plan development, station location selection, water quality monitoring, land use/treatment monitoring, and weather monitoring.

Water quality monitoring is an important aspect of the NPS program, especially if monitored water quality data is lacking, existing NPS pollution problems need to be quantified, and documentation is needed to show changes in water quality where alterations in land use practices have occurred. Monitoring will be conducted as part of NPS demonstration projects.

Demonstration Project: Mammoth Cave

Increasing public awareness of water quality problems at Mammoth Cave National Park has resulted in the development of the Mammoth Cave Karst Area Water Quality Oversight Committee. Its purpose is to achieve coordination among citizens, land users, and government agencies to monitor and improve the quality of waters in the karst area in south-central Kentucky.

A multi-agency technical committee consisting of representatives from local and state SCS offices, the ASCS, U.S. National Park Service, DOC, DOW, Kentucky Geological Survey, U.S. Geological Survey, Tennessee Valley Authority, University of Kentucky-College of Agriculture, Western Kentucky University-Department of Agriculture, and Western Kentucky University-Center for Cave and Karst Studies was established to work with the Mammoth Cave Karst Area Water Quality Oversight Committee in developing a nonpoint source water quality project for the Mammoth Cave area.

Local SCS and ASCS representatives prioritized farms within the Mammoth Cave vicinity for possible demonstration projects. Based on land resource needs, accessible water monitoring areas, and farmer cooperation, five farms were chosen as demonstration farms. Best management practices have been or will be implemented in a holistic, systems approach at two farms, and animal waste treatment facilities are being installed at three other farms. Multi-agency monitoring efforts will be used to document agricultural impacts on the quality of surface waters, groundwaters, and wetlands, and to address cross-media interactions. DOW has developed study plans for monitoring activities for each of the demonstration farms, has coordinated monitoring activities with other involved agencies, is implementing water quality monitoring, and will interpret and document changes in water quality that relate to the implementation of BMPs. These demonstration farms are being used for agricultural education purposes.

In order to execute project monitoring objectives, different sampling techniques are being employed at the various demonstration farms. For the most part, monitoring focuses on stormwater runoff. Automatic samplers were installed at two farms and will be used to evaluate agricultural BMPs. Animal waste lagoons are also being evaluated at these two farms.

The other three demonstration sites pertain only to feedlot operations. One of these operations drains into a second-order stream. An upstream - downstream biological/bacteriological/physicochemical monitoring approach is being employed there. Several sets of data have been collected at this location.

An animal waste lagoon has already been installed at one of the demonstration farms. Two sets of pre-BMP data were collected. These consisted of physicochemical and bacteriological analyses of grab samples. Because this is a no-discharge design system, post-BMP samples will probably not be collected.

The other demonstration farm was recently selected for the installation of an animal waste lagoon. Construction is planned for spring 1992. Some pre-BMP data have been collected for this site consisting of physicochemical and bacteriological analyses of grab samples.

Demonstration Project: Upper Salt River/Taylorsville Reservoir Watershed

Fishery problems in Taylorsville Reservoir, including fish kills and reduced fish reproduction, have prompted multi-agency concern over the water quality in the Upper Salt River watershed. The U.S. Army Corps of Engineers, Kentucky Department of Fish and Wildlife Resources, and DOW are investigating the water quality and fishery problems in the watershed. The basin is being impacted from excessive nutrient and sediment loading from agricultural activities, municipal wastes, faulty septic systems, and other land use activities. A comprehensive study plan, developed by NPS field team leaders, describes the objectives and activities of agencies involved in water quality monitoring in the upper Salt River/Taylorsville Reservoir (USR/TR) watershed.

The NPS program is conducting a study to determine the contribution of nonpoint source pollution from agricultural activities on the water quality of the upper Salt River and to document any changes in water quality that result from BMP implementation. The NPS field teams have obtained and compiled various land use/cover/treatment data including, but not limited to, geology, pesticide usage, number of failing septic systems, number of dairies, and animal waste facilities in the watershed. A U.S. Department of Agriculture (USDA) hydrologic unit area water quality (HUAWQ) project has been funded for this watershed. The overall goal of the USDA HUAWQ project is to abate

or prevent water quality degradation in both surface and groundwater sources of the USR/TR watershed over a five year period. To achieve this goal, the identified sources of contamination will be addressed by the use of best management practices.

An additional monitoring activity in the watershed relates to the development of Total Maximum Daily Loads (TMDLs). To develop a watershed-wide strategy for addressing both point and nonpoint source pollution in the USR/TR watershed, the DOW is developing TMDLs for the Upper Salt River. Total phosphorous is the primary pollutant parameter of concern for the TMDL. Targeted phosphorous values for point sources (waste load allocation) and nonpoint sources (load allocation) are being developed for the Upper Salt River. Total phosphorous TMDLs will be correlated with target chlorophyll α values in Taylorsville Reservoir.

Demonstration Project: Big South Fork/Bear Creek Interstate Watershed

The Big South Fork/Bear Creek demonstration project is located in an interstate watershed that lies in both Tennessee and Kentucky. Bear Creek flows north from Tennessee into Kentucky where it joins with the Big South Fork of the Cumberland River. A large portion of the Big South Fork watershed is classified and operated as a National River and Recreation Area by the National Park Service. Nonpoint source pollution impacts to Bear Creek begin outside the Big South Fork National River and Recreation Area (BSFNRRA) in Tennessee. The lower portion of Bear Creek lies in Kentucky, mostly within the BSFNRRA.

The Bear Creek drainage is affected by unreclaimed strip mines, numerous uncased, unmapped and abandoned oil and gas wells, agricultural activities, and suspected illegal industrial dump sites. An abandoned surface coal mine of approximately 70 acres, characterized by heavily eroding spoil banks and acid mine drainage, is one of several nonpoint source pollution problems in the upper reaches of the Bear Creek watershed.

The Tennessee Department of Health and Environment (TDHE), Nonpoint Source Program in cooperation with the Tennessee Department of Conservation (TDOC), Land Reclamation Program, has developed a rehabilitation plan for the Bear Creek watershed. The rehabilitation plan calls for surface mine reclamation and water quality monitoring. The TDOC Land Reclamation Program has studied the abandoned mine land sites and has implemented resource management BMPs. The BMPs include drainage control structures, subsurface limestone drains (anoxic alkaline trenches), aeration, and artificial wetlands through which to route acid mine drainage. The TDOC has implemented reclamation action and BMP implementation along Bear Creek.

In order to document changes in water quality associated with BMP implementation, the TDHE-NPS monitoring team is monitoring water quality before and after BMP implementation in the Tennessee portion of Bear Creek. To complete the watershed monitoring plan for this project, the Kentucky NPS monitoring team is conducting water quality monitoring in the Kentucky portion of Bear Creek. The team is supplementing Tennessee's activities by monitoring a station at the mouth of Bear Creek. In order to address possible temporal variability in water quality at Bear Creek, Rock Creek, a Kentucky Outstanding Resource Water, has been selected as an appropriate reference stream. An automatic water sampler has been installed at the Bear Creek station to collect rain event water samples. Quarterly biological monitoring is being conducted at both the impacted and reference stations in order to document recovery of the stream biota. Further, to ensure that biological data from Tennessee and Kentucky are comparable, Tennessee Standard Operating Procedures are being used by Kentucky for this particular project.

Demonstration Project: Fleming Creek

A project proposal for BMP monies for the Fleming Creek watershed was submitted to the USDA during the fourth quarter of 1991 by the SCS, Cynthiana, Kentucky, office with assistance from the DOW. This project was approved for funding in February 1992. Fleming Creek is a priority watershed; therefore, the Division will conduct water quality monitoring on this waterbody for the next several years.

Fleming Creek flows generally east to west and meets with the Licking River at mile 106.9. Fleming Creek's mainstem is 39 miles long draining an area of 61,670 acres. Further, this stream and its tributaries are contained almost entirely within Fleming County in northeastern Kentucky.

Fleming County ranks third statewide in number of dairy cattle. Eighty-five feedlot operations occur in this watershed, and the total cow population in the county exceeds 10,000 head. Moreover, an estimated 1,700,000 cubic feet of animal waste is washed into local streams annually. Because of this pollution source, water quality degradation has resulted.

Some data pertinent to this project have already been collected. In May 1990, officials from the Soil Conservation Service and DOW sampled several stations within the watershed in an effort to gather background information. Biological data and field water quality analyses were obtained for these stations.

A draft study plan has been developed for this project. Under the plan, the monitoring program will consist of three phases and will commence in the spring of 1992.

First, a watershed-wide bacteria and nutrient survey will be conducted. The purpose of this phase will be to examine the entire watershed with respect to point and nonpoint pollution sources in an effort to target those areas most affected by animal wastes. Data from this phase will also be used to locate a relatively unimpacted stream within the watershed for the purpose of a reference/control site.

Second, from these initial stations, several sites will be retained for long-term monitoring, including the reference/control station. The purpose of this second phase will be to measure water quality changes as a result of BMP installation in a holistic manner. Water quality data will center on nutrient concentrations for this phase.

Third, biological, physicochemical, and possibly bacteriological data will be collected at two of the more impacted (from animal waste) tributaries within the watershed and at the reference/control site. Preference will be given to the impacted subwatersheds for BMP installation. The purpose of this third phase is to evaluate water quality changes within "targeted" subwatersheds.

Data Collection/Data Management

A necessary and important function of the NPS program is the collection and management of NPS-related information. The cooperative, multi-agency nature of the program prescribes the reliance upon, and utilization of, existing data such as land use classification statistics, baseline water quality values, and best management practice evaluations. To this end, an NPS document library has been developed. All NPS-related documents are cataloged, and pertinent data are entered on computer for future retrieval. In addition, a computer literature search service has been identified and utilized for accessing other scientific and technical information pertinent to the program. Further, several statewide databases have been identified and utilized, including county-specific fertilizer and pesticide databases.

Education

To a large extent, the implementation of BMPs to control NPS pollution relies upon voluntary adoption by those who manage the use of Kentucky's land resources. Therefore, education plays a vital role in Kentucky's NPS Management Program. NPS education programs inform land users and other Kentucky citizens about the causes, consequences, and solutions (BMP use) for the various types and sources of NPS pollution.

The DOW NPS program supports and coordinates with a wide spectrum of NPS educational activities and programs. These programs are conducted by a number of cooperating agencies and institutions including the DOW, DOC, Division of Forestry, Division of Pesticides, local Conservation Districts, SCS, and the Kentucky Cooperative Extension Service. The DOW has provided program speakers for school classrooms, civic groups, trade organizations, and agency meetings. Additionally, exhibits and other educational materials have been provided for use in conferences, fairs, field days, and clean-up days.

Several NPS education projects are being conducted under the oversight of the DOW NPS program since they receive funding authorized by Section 319 of the Water Quality Act of 1987:

- The slide/video program and accompanying brochure, "Every Time It Rains," a general introduction to NPS pollution problems in Kentucky targeted to the general public, was produced by the Center for Math, Science, and Environmental Education at Western Kentucky University (WKU).

- WKU is also producing a video program on abandoned minelands and water quality, targeted to general audiences in Kentucky and Tennessee. It centers on the Bear Creek/Big South Fork demonstration project as an example of how these problems can be solved.

- The Gateway Region Environment-Education Network (GRE-EN), based in the Gateway District Health Department, is conducting a multi-faceted education program in the five-county Gateway region that targets agriculture, septic systems, and illegal dumps.

- The Warren County Conservation District has been conducting a number of educational activities that present NPS pollution problems and solutions arising from construction and urban runoff in karst regions, including contractor field days and the construction of a high-quality portable exhibit.

- The American Cave Conservation Association is building an exhibit in its American Museum of Caves and Karstlands, located in Horse Cave, which illustrates the many types of human activity that can pollute groundwater.

The WATER WATCH program (described in another section of this report) has proven to be a particularly valuable channel for educating citizens about NPS water quality problems and solutions. The WATER WATCH and NPS program staff are working to further expand WATER WATCH educational materials and programs to

include more information on BMPs and NPS pollution control, train participants to identify land use activities that are contributing to NPS pollution of their adopted waterbody, and collect data about water quality, aquatic life, and aquatic habitat conditions, including supplemental monitoring for NPS demonstration projects.

Update of the Nonpoint Source Pollution Assessment Report

Section 319 of the Water Quality Act of 1987 required all states to complete and submit a statewide Nonpoint Source (NPS) Pollution Assessment Report to EPA. The NPS Assessment Report was an attempt to identify all waters contaminated by NPS pollution and the NPS categories contributing to the problem. Kentucky's report was completed and approved by EPA in January 1989. EPA requires each state to update the report every year. The update of the NPS Assessment Report is a part of the 305(b) reporting process. The assessment update will identify navigable waters impacted by NPS pollution, detail changes that have occurred since the publication of the assessment in the 1990 305(b) report, and discuss NPS pollution in Kentucky's waters.

The NPS Pollution Assessment Report fulfills four requirements of Section 319 which are briefly summarized as follows:

1. Identify navigable waters that cannot attain or maintain applicable water quality standards or goals and requirements of the Water Quality Act of 1987 without additional action to control NPS pollution.

2. Identify categories and subcategories of NPS pollution that affect waters identified in Item 1.

3. Describe the process for identifying Best Management Practices (BMPs) and other measures to control NPS and to reduce such pollution to the "maximum extent practicable."

4. Identify and describe state and local programs for NPS control.

The discussion that follows relates to items 1 and 2. An example of the format used in Appendix C to identify NPS impacted waters is presented in Figure 2. Information contained in the appendix includes the waterbody code, waterbody name, NPS categories, parameters of concern, data sources, method of assessment, and designated uses not fully supported.

Figure 2. Data Table Organization for Nonpoint Source Impacted Waters

WATERBODY CODE	STREAM NAME	NPS CATEGORIES 1 2 3 4 5	PARAMETERS OF CONCERN	DATA SOURCES	MONITORED EVALUATED	USES NOT FULLY SUPPORTED
05100202-011	ROCKHOUSE CREEK	32 88 21 55 51	SED,MET,SO_4,Cl	305(b), 1988	MONITORED	WAH

Waterbody Name and Code

The identification of waters impacted by NPS pollution consists of the name of the principal stream, lake, wetland, or groundwater site. The code further delineates the water being assessed and has been indexed in a computer storage and retrieval system for easy access to information compiled for the waterbody.

NPS Category

The categories and subcategories of NPS pollution sources for each of the listed waters and their codes were established in EPA's guidance document for the preparation of the 1992 305(b) report. Refer to Appendix C for a listing of the codes and sources.

Additionally, the NPS categories were prioritized based on the severity of the NPS impact. Prioritized categories appear in numbered columns, indicating the relative severity of NPS impacts for a specific waterbody. Column one identifies the NPS impact of greatest concern.

Parameters of Concern

This information indicates the parameters which significantly contribute to the NPS impacts. These parameters include sediment, nutrients, bacteria, chemicals, pesticides, metals, etc. See Appendix C for a list of the parameters and their abbreviations.

Data Sources: Evaluated/Monitored

Information for Kentucky's NPS Assessment Report was gathered from many different sources. Both evaluated and monitored data were obtained and used to assess the NPS impacts to streams and lakes, wetlands, and groundwaters. Two levels of assessment were used to determine the impact of NPS pollution: monitored or evaluated. "Monitored" waters are those that have been assessed based on current site-specific water quality data. Waters were labeled as being "evaluated" if they were judged to be

impacted by NPS pollution based on field observations, citizen complaints, fish kill reports, land use data, etc. Additionally, specific water quality data more than five years old were labeled as evaluated. A bibliography listing data sources used for assessing nonpoint source impacts is provided in Appendix C.

Uses Not Fully Supported

Kentucky water quality regulations classify streams based on identifiable uses. The stream use classifications are: Warmwater Aquatic Habitat (WAH), Coldwater Aquatic Habitat (CAH), Domestic Water Supply (DWS), Primary Contact Recreation (PCR), Secondary Contact Recreation (SCR), and Outstanding Resource Waters (ORW). Uses in several waterbodies have been designated as threatened due to land-based activities in the area. Threatened use means that while a use or uses are fully supported in these waterbodies, NPS pollution arising from current land use activities in those watersheds could potentially make these waterbodies not support a use. The use classifications help protect public health and welfare and protect and enhance the quality of water for aquatic life. Partial and nonsupport are not differentiated in the tables, but these support categories are reported separately in the streams and rivers and lake assessment chapters in this report.

Surface and Groundwaters Impacted by Nonpoint Source Pollution

Rivers, Streams, and Lakes

Nonpoint source pollution of Kentucky's rivers, streams, and lakes is widespread, occurring in virtually every county of the state. Agricultural activities are the major sources of NPS pollution in Kentucky, both in terms of statewide distribution and the severity of pollution within a given area or watershed. Siltation from disturbed land is the primary agricultural pollutant and is the most common nonpoint source pollutant in Kentucky. It can cause navigational and flooding problems, threaten aquatic life, and transport large amounts of other pollutant materials. For example, nutrients and pesticides, two additional agricultural NPS pollutants, bind to, and are transported along with, sediment particles to streams and lakes.

Crop production is the primary agricultural land use activity affecting water quality. Because of its widespread occurrence, pastureland, especially where poorly maintained, is the second most common source of agricultural NPS pollution. Nutrient loading and bacterial contamination from feedlots, animal holding, and other livestock management areas are commonly occurring and often critical NPS problems throughout the Commonwealth. Other sources of agricultural NPS pollution include streambank erosion from unrestrained livestock, irrigated crop production, and specialty crop production (truck farming).

Surface coal mining activities are the most extensive and critical sources of NPS pollution that impact the streams and lakes of the Eastern and Western Kentucky Coalfields. Underground coal mine activities are a common secondary source of NPS pollution in these regions. Other mining-related nonpoint pollution sources in the state include runoff from limestone quarries and abandoned fluorspar mines.

Sediment, acid mine drainage, and elevated iron and sulfate concentrations are the principal pollutants associated with surface and underground coal mining activities. Sedimentation arises from stripping operations, haul roads, spoil banks on unreclaimed abandoned mine areas, deforested areas, sediment retention structures which have failed or do not operate properly, and sometimes surface disturbances associated with areas permitted for deep mining. Abandoned mines, which include underground mines and surface mines abandoned illegally or before mining regulations took effect, generally contribute the most severe acid water problems. Impacts from limestone quarries generally involve slight downstream increases in siltation and alkalinity.

Petroleum extraction activities occur in several regions of the Commonwealth. Improper brine discharges from oil and gas drilling operations result in high chloride levels, which in some areas are severe enough to eliminate aquatic fauna and adversely affect downstream public water supplies. Sedimentation from improperly constructed and maintained oil and gas facility service roads is also of concern.

Siltation of streams and lakes frequently results from silvicultural activities, or activities related to use of forest lands. Erosion can result from logging operations, saw mill runoff, reforestation, residue management, forest fires, haul road construction and maintenance, and woodland grazing of livestock. NPS pollution from silvicultural operations is widespread in Kentucky and is of special concern in steeply sloping areas.

Sediment is the major pollutant arising from several other source categories of NPS pollution. Construction activities (residential, commercial, or highway) can expose bare soil, resulting in severe erosion and sedimentation. Hydrologic habitat modification activities such as dredging, channelization, and flow regulation/modification, can alter the stream flow, disturb adjacent land area, and cause streambank erosion. Streambank erosion can also be caused by unrestrained access for livestock and increased runoff from impervious surfaces in urban areas.

Nonpoint source pollutants other than sediment are carried by runoff from several different categories of sources into Kentucky's streams and lakes. Stormwater runoff from urban areas washes nutrients, pesticides, bacteria, petroleum products, and a broad spectrum of other toxic substances into streams and lakes. On-site wastewater system runoff, especially from malfunctioning septic tanks, carries bacteria and nutrients to waterbodies. Solid waste and sewage is another frequently occurring NPS pollution category. While garbage, refuse, and debris primarily clog watercourses and create

aesthetic eyesores, they can also be a water quality problem because of pollutant residues remaining in the discarded containers and packaging. Finally, herbicides and other toxic substances that are used in highway and railroad right-of-way maintenance, discarded in landfills, or used in industrial land treatment, have been reported to pollute Kentucky's streams and lakes.

Appendix C presents an updated, comprehensive listing of Kentucky rivers, streams, and lakes impacted by NPS pollution. Both monitored and evaluated data were used to update the 1989 version of the Kentucky Nonpoint Source Pollution Assessment Report. In many cases, analysis of the updated information has resulted in changes to designated use-support determinations. Compared to earlier determinations, a greater number of rivers, streams, and lakes are now reported to not fully support their designated uses because of nonpoint sources of pollution. This is because additional available data have enabled use-support determinations to be made for more of the Commonwealth's waters.

The appendix consists of tables organized by the eight major Kentucky river basins and minor tributaries of the Ohio River. Impacted waters are identified by Waterbody System number. When comparing this updated report to earlier versions of the Kentucky Nonpoint Source Pollution Assessment Report, it is important to note that the earlier reports identified impacted waters by P.L.-566 watershed number, and that there is not a one-to-one correspondence between the Waterbody and P.L.-566 cataloging systems.

Wetlands

Kentucky possesses a diversity and abundance of wetland resources. The major wetlands are identified as riverine, palustrine, and lacustrine. Human activities which adversely impact wetlands include resource exploration and extraction, agriculture, hydrologic/habitat modification, silviculture, and construction. Resource extraction activities of some type probably affect more acres of wetlands in Kentucky than any other category. Nonpoint source pollutants such as acid mine drainage and sedimentation have adversely impacted the water quality, soil saturation time, and vegetation of these wetlands. Another resource extraction activity, petroleum exploration and extraction, also has a detrimental effect on wetlands. Oil well drilling often results in modifications to the existing drainage patterns, with subsequent changes in adjacent wetland ecosystems. Additionally, oil spillage and brine discharges from active oil wells adversely impact wetlands.

Historically, the conversion of wetlands for agriculture has resulted in substantial losses of wetland resources in the Commonwealth. In addition to direct wetland loss through conversion, agricultural nonpoint source runoff containing high concentrations of sediments, nutrients, and pesticides can potentially degrade wetland areas.

Riparian wetlands are impacted by hydrologic/habitat modifications such as channelization and flood control activities. Straightening channels for flood control can prevent the natural flooding of wetlands and subsequently reduce their mineral and organic nourishment. Constructed levees can cut off wetlands from floodplains or increase water levels, both of which alter the natural soil saturation period and can cause an adverse change in wetland functions.

Another threat to wetland resources is silvicultural activities. Timber harvesting is periodically desired on wetland areas with large stands of timber. However, logging operations typically result in soil compaction and sedimentation, resulting in wetland alteration and degradation.

Wetlands in Kentucky are also affected by construction activities. Land development, highway construction, and other construction related activities can result in both wetland conversion and nonpoint source pollutant loading to adjacent wetlands.

Groundwater

One of the most valuable resources in Kentucky is the state's extensive groundwater system. Groundwater is susceptible to nonpoint source (NPS) contamination. Karst regions, which comprise about 50 percent of the Commonwealth, are especially vulnerable. Approximately 48 of Kentucky's 120 counties are considered at high to moderate risk for groundwater contamination. The variety of geologic settings within Kentucky provide for significant local differences in the transport, accumulation, and breakdown of pollutants in the subsurface environment. The spatial variability of land uses also affects the distribution of pollutants in groundwater. Activities that can lead to groundwater contamination include agriculture, on-site sewage systems, waste disposal, resource exploration, development and/or extraction, improper well construction and operation, urban development, construction, underground injection of liquids, underground storage tank leakage, and spills.

Agricultural activities have a major impact on Kentucky's groundwater resources. Sedimentation is a common contaminant resulting from agricultural activities, especially in karst areas where sediment-laden streams sink into subterranean caverns. Other identified contaminants from agricultural activities are pesticides, nutrients, and bacteria. Some types of pesticides are soluble in water and are transported to aquifers by percolation of precipitation or by runoff from cropland. Excessive amounts of nitrates, nitrites, and bacteria can potentially render an aquifer useless. These contaminants may reach groundwater sources via percolation of precipitation through contaminated soil or runoff from animal feedlots, animal waste storage facilities, animal waste spreading operations, and sewage disposal systems.

Another major NPS impact to Kentucky's groundwater is improperly constructed or maintained on-site sewage disposal systems. Bacteria, nutrients, and potentially hazardous chemicals are the major parameters of concern. Leakage from these systems percolates through the soil into groundwater sources. Contamination of well water by on-site sewage systems can pose serious health problems to well users.

Contaminants such as PCBs, metals, bacteria, and hazardous chemicals are major parameters of concern in leachate and runoff from inadequately constructed or maintained solid or hazardous waste disposal facilities. In karst areas, the relatively rapid rate of contaminant transport through the soil into the aquifer results in the decreased ability of the soil to filter contaminants from the water. Where a leak occurs in a facility's liner, contamination could be swift and extensive. Runoff from such areas can potentially cause serious degradation problems in groundwater systems. Illegal dumping of wastes into sinkholes, along roadsides, or in secluded areas may also impact groundwater resources.

Resource exploration, development, and/or extraction activities can cause regional NPS groundwater contamination problems. Petroleum extraction activities, such as the construction and operation of oil and gas wells, can cause groundwater contamination. Elevated concentrations of chlorides and total dissolved solids in groundwater are associated with brine contamination from oil and gas well drilling activities. Brine can enter the groundwater system directly during the well drilling process via improper underground reinjection or as a result of waterflooding techniques commonly used for secondary petroleum recovery. Other parameters of concern from petroleum activities include metals and sulfates. Groundwater systems in Kentucky's coal regions are particularly vulnerable to NPS pollution impacts as well. The major parameters of concern regarding coal mining activities are elevated concentrations of metals and acid mine drainage. To a varying degree, groundwater quality near abandoned mines can be impacted by NPS contaminants. The Division of Abandoned Lands has had a significant number of requests from local governments for assistance in developing public water supplies where existing groundwater sources have been adversely impacted.

Urban areas and construction activities have been identified as sources of NPS contaminants of groundwater. In urban karst areas, groundwater is vulnerable to contamination by metals, bacteria, pesticides, and oil and grease from street runoff. Highly contaminated stormwater runoff can directly recharge groundwater through sinkholes used as auxiliary stormwater disposal facilities and sinking streams. Sediment is usually the major contaminant from construction activities.

Underground injection of liquid wastes, underground storage tanks, and spills are other NPS polluters of groundwater. Underground injection of liquid wastes will severely impact an aquifer if the substance is injected directly into the aquifer. The parameters of concern are dependent upon the identity of the injected liquid. Leaking underground storage tanks can also cause localized groundwater damage. Petroleum

products can readily percolate into underlying aquifers. Spills of toxic materials can reach groundwater systems by percolation or surface water recharge. Contamination from a spill can cause major degradation of a groundwater source.

Not only does nonpoint source pollution affect the quality of groundwater used for drinking, it also threatens aquatic organisms. Subterranean river basins and aquifers provide a unique habitat for certain endangered and rare species. Three rare animal species, Amblyopsis spelaea (Northern cavefish), Typhlichthys subterraneus (Southern cavefish), and Palaemonias ganteri (Kentucky cave shrimp) are known to inhabit subterranean waters in Kentucky. Survival of these species is directly related to suitable groundwater quality in the Mammoth Cave region. The only known population of Palaemonias ganteri is found in the Mammoth Cave region. It is listed as a federally endangered species by the U.S. Fish and Wildlife Service because it "is in danger of extinction throughout all or a significant portion of its range." Both A. spelaea and T. subterraneus are candidates for federal listing.

Oil and gas drilling presently occurs in several groundwater basins that supply Mammoth Cave. Brine from such activities commonly reaches aquifers potentially creating physicochemical changes in groundwater quality. Finally, agricultural activities resulting in sedimentation, excessive nutrients, and the introduction of pesticides into the groundwater can potentially impact rare cave species.

Appendix C identifies groundwater basins that are known to be impacted by nonpoint source pollution. They were assessed using both evaluated and monitored data. Evaluated data were based on non-monitored water quality information provided by DOW groundwater staff and the U.S. Geological Survey. More baseline data are needed to effectively evaluate the extent of contamination present in Kentucky's groundwater.

SURFACE WATER MONITORING PROGRAM

An effective water monitoring program is essential for making sound pollution control decisions and for tracking water quality improvements. Specifically, Kentucky's ambient monitoring program provides monitoring data to identify priority waterbodies upon which to concentrate agency activities, to revise state water quality standards, to aid in the development of wasteload allocations, and to determine water quality trends in Kentucky surface waters. As outlined in the Kentucky Ambient Surface Water Monitoring Strategy, the major objectives associated with the Ambient Monitoring Program are:

1. To operate a fixed-station monitoring network meeting chemical, physical, and biological data requirements of the state program and EPA's Basic Water Monitoring Program (BWMP).

2. To conduct intensive surveys on priority waterbodies in support of stream use designations, wasteload allocation model calibration/verification, and other agency needs.

3. To store data in EPA's STORET system, a computerized water quality data base.

4. To coordinate ambient monitoring activities with other agencies (EPA, Ohio River Valley Water Sanitation Commission, U.S. Geological Survey, U.S. Army Corps of Engineers, etc.).

Following is a discussion of components of the monitoring program (fixed-station monitoring, biological monitoring, intensive surveys, and reference reaches). Elements of the toxicity testing program relating to surface waters, and a citizen education program called WATER WATCH, which includes a monitoring element, are also discussed.

Fixed-Station Monitoring Network

For the reporting period (1990-1991) the Division of Water's physicochemical network consisted of a balance of 45 stream stations located in ten river basins. In this period some stations were deleted, others relocated, and some new stations were established, based on a review of monitoring objectives. Table 41 lists stations sampled and Figure 3 depicts station locations. Samples were collected monthly at each station for the variables listed in Table 42. Excluding the mainstem of the Ohio River, water quality information generated by the fixed-station network was used to characterize 1,432 stream miles within the state.

Table 41
Fixed-Station Monitoring Network

Map No.	Station Name	RMI	Road Location
1	Tug Fork at Kermit	35.1	KY 40
2	Levisa Fork near Louisa	29.6	KY 644
3	Levisa Fork near Pikeville	114.6	KY 1426
4	Little Sandy River near Argillite	13.2	KY 1
5	Tygart's Creek near Load	28.1	KY 7
6	Kinniconick Creek near Tannery	10.4	KY 1149
7	Licking River at Claysville	78.2	US 62
8	N. Fork Licking River at Milford	6.9	KY 19
9	S. Fork Licking River at Morgan	11.7	KY 1054
10	Licking River at West Liberty	226.4	US 460
11	Kentucky River at Frankfort	66.4	St. Clair St. Bridge
12	Kentucky River at Camp Nelson	135.1	Old US 27
13	Eagle Creek at Glencoe	21.5	US 127
14	South Elkhorn Creek near Midway	25.3	Lundy Farm Rd Bridge
15	Dix River near Danville	34.6	KY 52
16	Red River at Clay City	21.6	KY 11/15
17	Red River near Hazel Green	68.5	KY 746
18	Kentucky River at L&D 11	201.0	L&D 11
19	N. Fork Kentucky River at Jackson	304.5	Old KY 30
20	M. Fork Kentucky River at Tallega	8.3	KY 708
21	S. Fork Kentucky River at Booneville	12.1	KY 28
22	Salt River at Shepherdsville	22.9	KY 61
23	Salt River at Glensboro	82.5	KY 53
24	Rolling Fork near Lebanon Junction	12.3	KY 434
25	Beech Fork near Maud	48.1	KY 55
26	Pond Creek near Louisville	15.5	Manslick Rd. Bridge
27	Green River near Island	74.4	KY 85
28	Pond River near Sacramento	12.4	KY 85
29	Rough River near Dundee	62.5	Barrets Ford Bridge
30	Mud River near Gus	17.4	KY 949
31	Barren River at Bowling Green	37.5	College St. Bridge
32	Green River at Munfordville	225.9	US 31W
33	Nolin River at White Mills	80.9	White Mills Bridge
34	Bacon Creek near Priceville	7.2	C. Avery Rd. Bridge
35	Tradewater River near Sullivan	15.1	US 60/641
36	Little River near Cadiz	24.4	KY 272
37	Cumberland River at Burkesville	422.6	Boat ramp
38	S. Fork Cumberland River at Blue Heron	44.7	Old Rail Bridge
39	Rockcastle River at Billows	24.4	Old KY 80
40	Horse Lick Creek near Lamero	7.5	Daugherty Rd. Ford
41	Cumberland River at Cumberland Falls	562.3	KY 90
42	Cumberland River at Pineville	654.4	Pine St. Bridge
43	Clarks River at Almo	53.5	Almo-Shiloh Rd. Bridge
44	Mayfield Creek near Blandville	10.8	KY 121
45	Bayou de Chien near Clinton	15.1	US 51

Figure 3

Fixed-Station Monitoring Network

Stream Station Locations

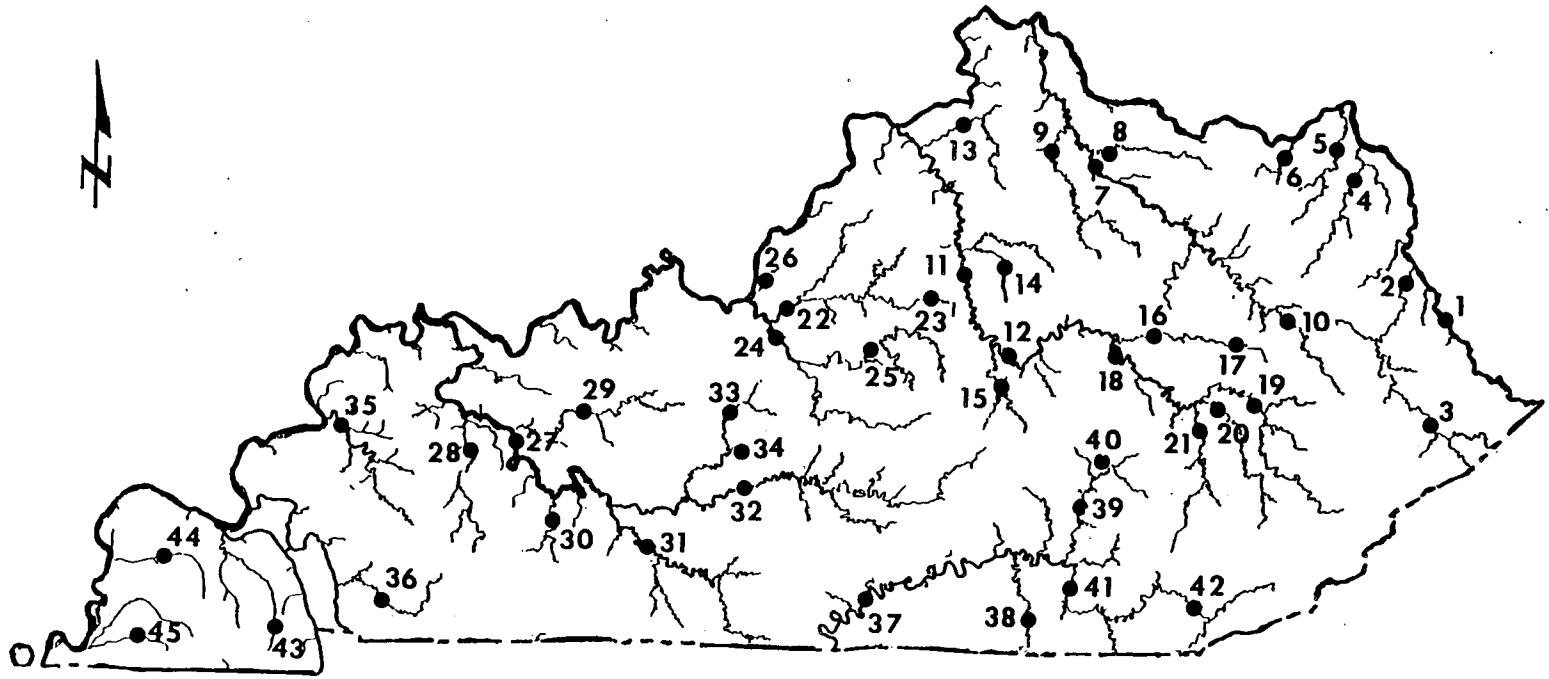

Table 42
Stream Fixed-Station Variable Coverage

Variables	Variables
Field Data	**Laboratory Data**
Weather code (47501)	Acidity, mg/l (00435)
Air temp, °C (00020)	Alkalinity, mg/l (00410)
Water temp, °C (00010)	BOD, 5-day, mg/l (00310)
Specific conductance uS/cm @ 25C (00094)	Chloride, mg/l (00940)
D.O., mg/l (00299)	Sulfate, dissolved mg/l (00946)
pH, S.U. (00400)	Suspended solids, mg/l (00530)
Turbidity, N.T.U. (82078)	TOC, mg/l (00680)
Flow, cfs (00060)	
Minerals, Total*	
Calcium, mg/l (00916)	
Magnesium, mg/l (00927)	**Metals, Total***
Potassium, mg/l (00937)	
Sodium, mg/l (00929)	Aluminum, ug/l (01105)
Hardness, mg/l (00900)	Arsenic, ug/l (01002)
	Barium, ug/l (01007)
Bacteria	Cadmium, ug/l (01027)
	Chromium, ug/l (01034)
Fecal coliform, colonies per 100 ml (31616)	Copper, ug/l (01042)
	Iron, ug/l (01045)
Nutrients	Lead, ug/l (01051)
	Manganese, ug/l (01055)
NH_3-N, mg/l (00610)	Mercury, ug/l (071900)
NO_2 + NO_3-N, mg/l (00630)	Zinc, ug/l (01092)
TKN, mg/l (00625)	
Total phosphorus, mg/l (00665)	

*Total as Total Recoverable, Note: STORET codes are in parentheses

In addition to water quality information generated by the state's fixed-station network, the Division supports and uses information collected by the Ohio River Valley Water Sanitation Commission (ORSANCO) at five major tributary stations. These stations include: Cumberland River below Lake Barkley Dam, Tennessee River at Paducah, Green River near Sebree, Licking River at Covington, and Big Sandy River near Louisa. The Division also uses information from stations maintained as part of the U.S. Geological Survey's current monitoring programs.